SCOURING-SEDIMENTATION BALANCE FOR GULLY REACHES AFFECTED BY CHECK DAMS IN MEDITERRANEAN ENVIRONMENTS

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1. Introduction

Many of the geomorphological impacts caused by check dams are usually fairly common in torrential channels (bed agradation upstream into the sedimentary wedges, deepening and narrowing of the *bankfull* channel downstream, etc). Nevertheless, the extent of these impacts and consequently the degree of effectiveness of the cross-structures is very different depending on the environmental characteristics of the catchments and on the hydrological rectification systems (spatial distribution of check dams, location, number and type of work). A clear indicator of such an influence is the channel response to the deficit and overfeeding of sediments (Brandt, 2000; Lenzi *et al*., 2003; Marion *et al*., 2006; Comiti *et al*., 2005). In such a way, this study has as its objective to show the influence of staggered check dams of gabions on the scouring-sedi-mentation balance in Mediterranean ephemeral gullies submitted to Projects of Hydrological Forest Restoration (PHFR).

For areas of study, two semiarid gullied catchments with a strong tendency to dry up have been chosen: Torrecilla and Cárcavo catchments (South-east Spain). The Torrecilla catchment (15.5 km^2) shows a gullied area develo-ped on metamorphic materials (slates, phyllites, schists and quartzites), while the Cárcavo catchment (34.8 km^2) is drained by ephemeral channels and gullies that dissect deeply the Miocene marls and Quaternary pediments. The hydrological rectification projects undertaken are similar in both catchments: 33 and 40 check dam series were cons-tructed respectively during the 1970s, the majority of them with gabions (Fig. 1).

2. Methodology

The alluvial-fill thickness in each point of the sedimentary wedge, behind the check dam, has been calculated using the values of elevation of a three-dimensional image generated from the surfaces of the original and current beds. The surface area of the wedge was measured with GPS (Geoexplorer3C Trimble©) and the bottom area (bed previous to filling) deduced from trigonometrical calculations and from the topographical plans included in the memory of the PHFR (Ministry of Agriculture, 1972). For the cubing of the erosion wedges, consecutive channel cross-sections have been topographied, with intervals of separation of 10 to 20 m depending on each case. Taken from these have been obtained by interpolation other intervening cros-sections setting intervals of 5 m. As much as the spatial interpolation of the cross-sections as the estimation of their geometrical data, in particular of the area, is carried out via the HEC-RAS software.

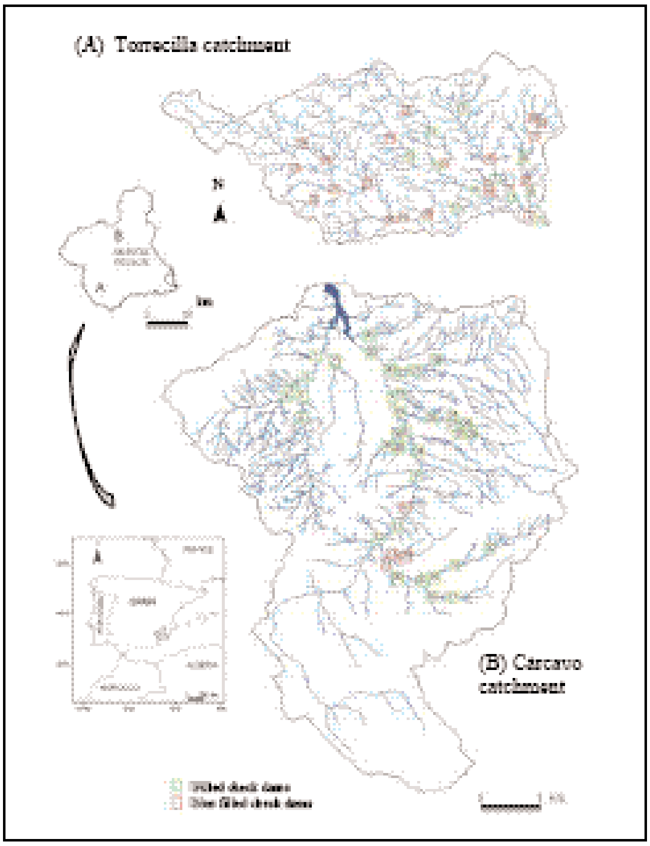

Fig. 1. Location of check dams in the Torrecilla and Cárcavo catchments. Murcia Region, Spain.

The field information has been simplified and the relations between variables explained through factorial analysis of principal components (APC), applying a orthogonal varimax rotation.

3. Results y discussion

The comparison between the sediments retained upstream (Up) of check dams and the eroded downstream (Dw) shows marked differences between the two catchments under study (Fig. 2), associated with its environ-

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mental characteristics, especially lithology and slopes. In the case of the Cárcavo, most retention, scouring, and total removal of sediments is concentrated in the lower reach of the main channel, as it was hoped; but it did not happen in the Torrecilla catchment, distinguished by a drainage network palmated with three main arteries (streams of Navazo, Cocón and Torrecilla s.s.), whose lower and middle reaches hoard the main proportion of sediments at the same time as having recently built check dams which are practically empty.

- In the Cárcavo catchment the average mass of excavated material downstream from check dams (4,794 t/check dam) represents 70.9 % of that stored upstream (6,765.7 t/check dam). On the contrary, in the Torrecilla catchment such a proportion is reduced to 31.2 % of the 3,146 t/check dam which makes up the average mass of the sedimentary wedges.
- The absolute balance of retention versus bed scour deduced from the construction of check dams is considerably greater in the Cárcavo catchment.
- The total valuation of removal caused by check dams in the Cárcavo (6.61 $t \cdot ha^{-1} \cdot year^{-1}$) is more than double that which is reached in the Torrecilla catchment.

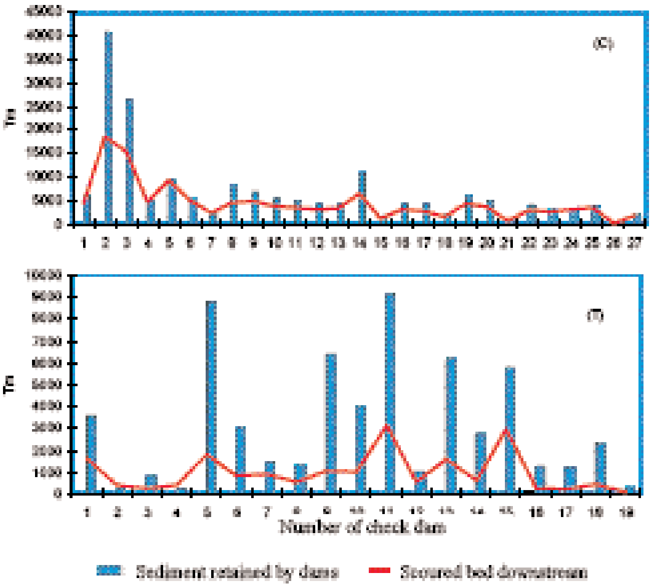

Fig. 2. Comparison of the sediments retained by check dams and the eroded downstream in the Cárcavo (C) and Torrecilla (T) catchments. Period 1970-2005.

- Positions of the variables involved in graphs for CP1 and CP2 dimensions (Fig. 3) can be seen with regard to the factorial rotated axis.
- They are all well represented on the plan, and the majority of the factorial coefficients accumulated in the higher right quadrant.

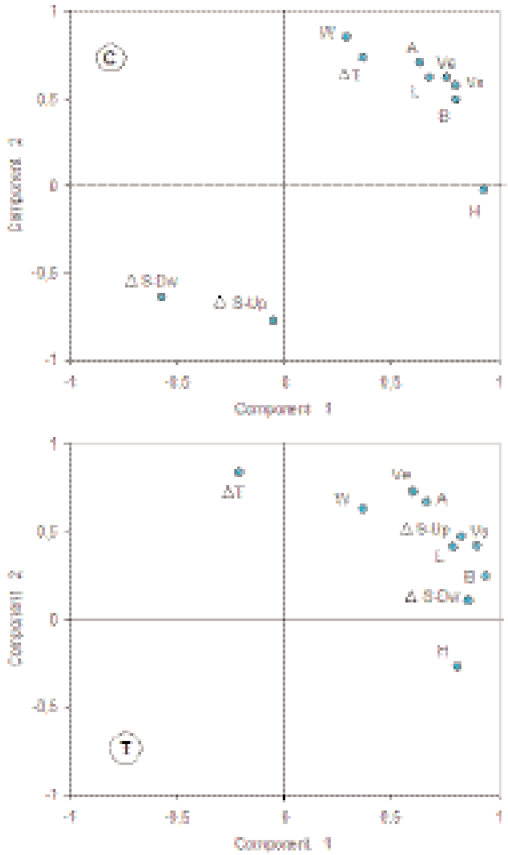

Fig. 3. Graph of components in rotated space. Geometrical variables of the sedimentary wedge: area (A), length (L), average width (W), maximum thickness (H), volume of retained sediments (Vs). Other variables: Ve = volume of the scour wedge; B = scouring-sedimentation balance; ΔS-Up = decrease of slope upstream of check dams; ΔS-Dw = decrease of slope downstream of check dams; ΔT = change in bed texture between upstream and downstream reaches ($D_{84}Dw - D_{84}Up$).

4. Conclusions

Scouring-sedimentation balance caused by check dams is greater in the Cárcavo catchment, where an important volume of bed material is removed. This is due to a high soil erodibility, scanty influence on the hillslope stability, low reduction in bedload transport rate and strong local bed scour. The gravel bed in the Torrecilla rambla is more stable.

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